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Final

Decision Document
SWMUs 1 and 24

Naval Air Station Oceana
Virginia Beach, Virginia

NAVFAC
Naval Facilities Engineering Command
NAVFAC MID-ATLANTIC

Prepared for

Department of the Navy
Naval Facilities Engineering Command
Mid-Atlantic

Contract No. N62470-02-D-3052
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September 2008

Prepared by
CH2MHILL

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Contents

Acronyms and Abbreviations

1,1-DCA	1,1-dichloroethane
amsl	above mean sea level
BERA	Baseline Ecological Risk Assessment
bgs	below ground surface
BTAG	Biological and Technical Assistance Group
BTEX	benzene, toluene, ethylbenzene, and xylenes
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
cis-1,2-DCE	cis-1,2-dichloroethene
CMS	Corrective Measures Study
COPC	Chemical of Potential Concern
CSM	Conceptual Site Model
CT	Central Tendency
DCE	Dichloroethene
DD	Decision Document
EDB	ethylene dibromide
ft	feet
FS	Feasibility Study
HHRA	Human Health Risk Assessment
HI	Hazard Index
HQ	Hazard Quotient
IAS	Initial Assessment Study
LNAPL	light non-aqueous phase liquid
LOAEL	Lowest Observable Adverse Effect Level
LTM	Long Term Monitoring
LUC	Land Use Control
MCL	maximum contaminant level
µg/kg	microgram per kilogram
µg/L	micrograms per liter
mg/kg	milligrams per kilogram
NAS	Naval Air Station
Navy	United States Department of the Navy
NCP	National Oil and Hazardous Substances Pollution Contingency Plan

NOAEL	no observed adverse effect level
ORC®	Oxygen Release Compound
PAH	polycyclic aromatic hydrocarbons
PCB	polychlorinated biphenyls
POL	petroleum, oil, lubricant
PP	Proposed Plan
PRG	Preliminary Remediation Goal
RAB	Restoration Advisory Board
RAO	Remedial Action Objective
RBC	Risk Based Concentration
RCRA	Resource Conservation and Recovery Act
RFI	RCRA Facility Investigation
RME	Reasonable Maximum Exposure
RPM	Remedial Program Manager
SARA	Superfund Amendments and Reauthorization Act
SERA	Screening Ecological Risk Assessment
SWMU	Solid Waste Management Unit
TCE	trichloroethene
TPH	total petroleum hydrocarbons
TRC	Technical Review Committee
USEPA	United States Environmental Protection Agency
VDEQ	Virginia Department of Environmental Quality
VOC	Volatile Organic Compound

SECTION 1

Declaration

1.1 Site Name and Location

Solid Waste Management Units (SWMUs) 1 and 24
Naval Air Station (NAS), Oceana
Virginia Beach, Virginia
U.S. Environmental Protection Agency (USEPA) ID No. VA2170024606

1.2 Statement of Basis and Purpose

This Decision Document (DD) presents the selected remedy for SWMUs 1 and 24 at NAS Oceana in Virginia Beach, Virginia. SWMUs 1 and 24 were initially investigated following the requirements of the NAS Oceana Resource Conservation and Recovery Act (RCRA) 3008 (h) Consent Order. However, in July 1998, the United States Department of the Navy (Navy), the Virginia Department of Environmental Quality (VDEQ), and the USEPA agreed to conduct site remediation activities at NAS Oceana following the procedural and substantive requirements of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) program [42 U.S.C. §§9601 et seq., 10 U.S.C. §2701 et seq., and Executive Order 12580 (January 23, 1987)]. Therefore, the selected remedy was chosen in accordance with CERCLA, as amended by the Superfund Amendments and Reauthorization Act (SARA) of 1986 and to the extent practicable, with the National Oil and Hazardous Substances Pollution Contingency Plan (NCP). This decision is based on the information contained in the Administrative Record for these sites.

The Navy is the lead agency and provides funding for site cleanup at NAS Oceana. The USEPA and VDEQ concur with the selected remedy.

1.3 Description of the Selected Remedy

Seventeen SWMUs, including SWMUs 1 and 24, were identified as needing further investigation during the Phase I RCRA Facility Investigation (RFI) at NAS Oceana. No further action (NFA) DDs have been completed for twelve of these SWMUs (SWMUs 2D, 11, 15, 16/16GC, 18, 19, 20, 21, 22, 23, 25, and 26). An action DD for Continued Enhanced Bioremediation, Long Term Monitoring (LTM) and Land Use Controls (LUCs) at SWMUs 2B, 2C, and 2E is scheduled in 2008.

The selected remedy for SWMUs 1 and 24 is no action. Concentrations of site-related organics and inorganics in media from SWMUs 1 and 24 no longer pose unacceptable risk to human health or the environment. Therefore, no action is necessary to protect public health, welfare or the environment from former releases of hazardous substances at these SWMUs.

1.4 Statutory Determination

The no action decision is protective because media at SWMUs 1 and 24 no longer pose unacceptable risks or hazards to human health or the environment. The selected remedy for SWMUs 1 and 24 allows for unlimited use and unrestricted exposure because no hazardous substances, pollutants, or contaminants remain at either site at concentrations posing unacceptable risks; therefore, a five-year review will not be required for either SWMU.

1.5 Authorizing Signatures

9/24/08

CAPT M. R. Hunter
Commanding Officer
NAS Oceana

Date

SECTION 2

Decision Summary

This DD describes the selected remedial action for SWMUs 1 and 24 at NAS Oceana, Virginia Beach, Virginia. USEPA and VDEQ concur with the selected remedy.

2.1 Site Name, Location, and Description

NAS Oceana, located in Virginia Beach, Virginia, was established in 1940 as a small auxiliary airfield. Since 1940, NAS Oceana has grown to more than 16 times its original size and is now a 6,000-acre master jet base supporting a community of more than 9,100 Navy personnel and 11,000 dependents. The primary mission of NAS Oceana is to provide the personnel, operations, maintenance, and training facilities to ensure that fighter and attack squadrons on aircraft carriers of the U.S. Atlantic Fleet are ready for deployment. SWMUs 1 and 24 are located within NAS Oceana (**Figure 2-1**). Specific locations and descriptions of each SWMU are provided below.

SWMU 1

SWMU 1, the West Woods Oil Disposal Pit, is located in the northwest part of NAS Oceana, approximately 1,000 feet (ft) west of abandoned Runway 9 (**Figure 2-2**). The SWMU was originally an open pit, 50 to 100 ft in diameter, where 110,000 gallons of waste oil, fuel, solvents, various chlorinated and aromatic hydrocarbons, aircraft maintenance chemicals, paints, paint thinners and strippers, and lubricants were reportedly disposed of from the mid-1950's until the early 1960's. Metal, concrete, and other debris were also disposed of in the pit or were included in the fill material. During a significant storm event in 1962, the pit's contents are believed to have washed into an adjacent storm water drainage ditch located 100 ft to the west. As a result, waste disposal ceased and the pit was filled with soil.

The area immediately surrounding the pit is dominated by trees, shrubs, and grass. The eastern perimeter of the SWMU is comprised of mowed and old field grasses, impervious surfaces, and a small emergent freshwater wetland located approximately 250 ft to the east. Surface drainage is directed toward north-south and east-west oriented drainage ditches that are part of engineered storm water and spill control system for NAS Oceana.

SWMU 24

SWMU 24, the Building 840 Bowser, is located in an industrial area of NAS Oceana near Building 840 (**Figure 2-3**). SWMU 24 consisted of a waste-oil bowser (a portable tank) located in the southern portion of the Building 840 compound. Waste solvents and oils generated between 1977 and 1982 at the equipment maintenance garage in Building 840 were hand carried over the unpaved lot and poured into the bowser. The bowser was then transported to the tank farm for disposal. Environmental concerns were first recognized at this site during the 1988 RFI site inspection when heavy staining of the ground was observed in the area surrounding the waste oil bowser. The waste oil bowser has since been removed from the site. SWMU 24 currently consists of a fenced gravel area surrounded by a

perimeter of brush, forest, and mowed lawn. With the exception of the forested area, the site is used as a parking and storage area.

2.2 Site History and Enforcement Activities

The following subsections provide summaries of the previous investigations conducted at SWMUs 1 and 24. No enforcement activities have been initiated at SWMUs 1 and 24.

2.2.1 SWMU 1

Initial Assessment Study (RGH, 1984)

An Initial Assessment Study (IAS) at NAS Oceana identified 16 potential areas of concern through a review of historical records, aerial photographs, site visits, inspections, and interviews with NAS Oceana personnel regarding waste generation, handling, and disposal practices. The IAS indicated that petroleum, oil, lubricant (POL)-related contaminants mixed with hazardous waste oil, fuel, and solvents were likely present within the soil and on the water table at SWMU 1 (referred to as Site 1 in the IAS). Consequently, the site was recommended for further investigation.

Round 1 Verification (CH2M HILL, 1986)

On the basis of the IAS's results and recommendations, a Round 1 Verification study was conducted at SWMU 1 to evaluate the potential for petroleum contamination in groundwater from the former pit. Three groundwater samples were collected from the vicinity of the former pit and analyzed for volatile organic compounds (VOCs). Low concentrations of VOCs were detected in the groundwater. The report concluded that there was very little potential for offsite migration of VOCs, but because the exact location of the former pit was unknown, additional investigation was warranted.

Interim RCRA Facility Investigation (CH2M HILL, 1991)

An Interim RFI was conducted at SWMU 1. Five groundwater samples were collected and analyzed for VOCs, total petroleum hydrocarbons (TPH), ethylene dibromide (EDB), polychlorinated biphenyls (PCBs), and 2,3,7,8 dioxin. TPH and VOCs were detected in groundwater. Surface water and sediment samples were collected and analyzed for only those parameters detected in groundwater. TPH was detected in sediment collected from the main drainage ditch west of the former pit at concentrations up to 1,260 milligrams per kilogram (mg/kg). Petroleum constituents were not present in surface water at concentrations greater than Virginia groundwater quality standards and surface water quality standards for total aromatic and allophatic hydrocarbons. The Interim RFI recommended additional investigations to further characterize the nature and extent of contamination in groundwater, soil, and sediment at SWMU 1.

Phase I RCRA Facility Investigation (CH2M HILL, 1993)

Eleven soil and groundwater and four surface water and sediment samples were collected during the Phase I RFI to further characterize the nature and extent of contamination at SWMU 1. The soil results indicated that the soil contamination was limited to polycyclic aromatic hydrocarbons (PAHs) and VOCs with minor amounts of PCBs and pesticides.

PAHs, PCBs and pesticides were not detected in groundwater. Only benzene, toluene, ethyl benzene, and xylene (BTEX) and 1,1-dichloroethane (1,1-DCA) were present in the shallow groundwater at isolated sample locations. There was no indication of site-related contamination in the deeper groundwater or in sediment and surface water in the drainage ditch west of the site. Therefore, the Phase I RFI concluded that the contamination is likely limited to waste oil and petroleum-related compounds in soil and shallow groundwater and recommended additional sampling to delineate the lateral extent of contamination in soil and groundwater during the Corrective Measures Study (CMS).

Corrective Measures Study (CH2M HILL, 1996)

The CMS included delineating the extent of soil contamination and additional groundwater sampling to confirm the presence of light non-aqueous phase liquid (LNAPL) on top of the water table and evaluate potential corrective measures for treatment. The results confirmed the presence of waste oil and petroleum-impacted soil. Approximately 0.04 ft of LNAPL was present on top of the water table. An extraction well and monitoring system were installed to test the viability of extracting LNAPL from the top of the water table. Two pilot tests were completed; however, no LNAPL was recovered during either test. The lack of recovery was attributed to the tightness of the silts that contained the LNAPL.

Phase III RCRA Facility Investigation (CH2M HILL, 1999)

During the Phase III RFI, the Navy installed two-solar powered skimmers and began recovering LNAPL from the top of the water table at SWMU 1. In addition, six subsurface soil samples were collected and analyzed for dioxins and furans; the concentrations of these did not exceed the USEPA screening value of 1 microgram per kilogram (µg/kg).

Human Health Risk Assessment (CH2M HILL, 2001)

The surface soil, subsurface soil, surface water, sediment, and groundwater data collected during the Phase I and III RFIs and the CMS were evaluated to assess potential risks to current and future human receptors. The Human Health Risk Assessment (HHRA) concluded that exposure to naphthalene in groundwater by future residents may pose a potential unacceptable risk. Groundwater concentrations of naphthalene used for the risk assessment ranged from not detect to 208 micrograms per liter (µg/L). There were no other unacceptable risks associated with any other contaminants. The detailed results of the HHRA are included in Section 2.7 of this DD.

Ecological Risk Assessment (CH2M HILL, 2000 and 2001)

The surface soil, surface water, sediment, and groundwater data collected during the Phase I and III RFIs and the CMS were evaluated to assess potential risk to terrestrial and aquatic receptors. A Screening Ecological Risk Assessment (SERA) and a Baseline Ecological Risk Assessment (BERA) (through Step 3a) were performed for SWMU 1 in accordance with USEPA guidance and Navy policy. Negligible site-related ecological risks were identified at SWMU 1 based on the limited habitat and similarity of site and base-wide background concentrations. A detailed summary of the SERA and BERA is included in Section 2.7 of this DD.

Feasibility Study (CH2M HILL, 2001)

A Feasibility Study (FS) was completed to develop and evaluate remedial alternatives to prevent unacceptable human health risks from future residential exposure to naphthalene in groundwater. Three remedial alternatives were evaluated: (1) No Action, (2) Free-Product Removal with Institutional Controls and LTM, and (3) Application of Oxygen Release Compound (ORC®) and Free-Product Removal with Institutional Controls and LTM. Each remedial alternative was analyzed with respect to the nine evaluation criteria provided in the NCP. The alternatives were then compared to one another with respect to their rating under the NCP evaluation criteria. On the basis of the comparative analysis, Free-Product Removal with Institutional Controls and LTM (Alternative 2) was selected as the Preferred Alternative. A risk-based preliminary remediation goal (PRG) was calculated for naphthalene in groundwater. The calculated PRG for naphthalene was 170 µg/L. PRG calculation tables are included in Appendix A.

Hot-Spot Remediation Baseline Sampling and Background Investigation (2003)

In order to evaluate the potential for inclusion of SWMU 1 in the proposed in-situ hot-spot remediation that was being developed for other Oceana SWMUs (SWMUs 2C and 2E), additional samples were collected from two wells at SWMU 1 to further characterize the nature and extent of organic concentrations in groundwater. This sampling was conducted in conjunction with the facility-wide background investigation for select inorganics.

Naphthalene was detected in the sample from OW01-PZ03 at a concentration of 170 µg/L, which is equal to the calculated PRG for the site. Benzene was also detected in the sample from OW01-PZ03 at a concentration of 6.2 µg/L, which is just above the Maximum Contaminant Level (MCL) of 5 µg/L. OW01-PZ03 was the only well at SWMU 1 in which these two constituents were detected at concentrations equal to or exceeding the PRGs or MCLs during this sampling event.

Additional Groundwater Sampling and Product Thickness Measurements (2004)

Since the concentrations of naphthalene detected in the 2003 study were very close to the PRG concentration, three additional rounds of sampling were completed (July 2003, November 2003, and January 2004) to determine whether treatment would be necessary at SWMU 1. Although benzene was not identified as a risk driver in groundwater (CH2M HILL, 2001), historical benzene concentrations from OW01-PZ03 were above the MCL; consequently, it was decided to also analyze the groundwater samples from this well for benzene. Since historical concentrations of naphthalene exceeded the PRG in samples from OW01-PZ03 and OW01-MW04, groundwater samples from these wells were analyzed for naphthalene. Other site wells without historical exceedances of screening criteria were not resampled. Concentrations of naphthalene and benzene did not exceed the corresponding PRG and MCL values during any of the three rounds of sampling (**Figure 2-4**). During the final three rounds of sampling, concentrations of naphthalene ranged from 7 µg/L to 150 µg/L and concentrations of benzene ranged from 2.9 µg/L to 5 J µg/L. During the final round of sampling, LNAPL thickness in OW01-PZ03 was 0.13 ft. No product was detected in OW01-MW04. Therefore, the Preferred Alternative identified in the 2001 FS (Alternative 2, Free-Product Removal with Institutional Controls and LTM) was deemed to be no longer necessary.

2.2.2 SWMU 24

Phase I RCRA Facility Investigation (CH2M HILL, 1993)

The RFI was conducted to characterize the soils in the vicinity of the former waste-oil bowser. Two soil samples were collected to a depth of 1 ft below ground surface (bgs) and analyzed for inorganics, VOCs, PAHs, and TPH. Benzo(a)pyrene and several inorganics were detected in the soils above mean background concentrations and/or human health-based screening levels. The RFI recommended additional characterization to determine if the potential soil contamination at the site was petroleum-related.

Petroleum Oil Lubricant Corrective Measures Study (CH2M HILL, 1994)

As part of a CMS for Petroleum Contaminated Sites (POL-CMS), surface and subsurface soil was sampled at six locations and analyzed for TPH, PAHs, and inorganics to delineate the petroleum-related contamination to support a potential soil removal. Additionally, four temporary monitoring wells were installed and groundwater samples were collected and analyzed for TPH, VOCs, PAHs, and inorganics. Most of the soils contained TPH concentrations above the VDEQ storage tank guidance notification standard of 100 mg/kg. TPH and VOCs were detected in groundwater. The POL-CMS recommended excavation of the TPH-contaminated soil and additional investigation to further characterize the nature and extent of groundwater contamination.

Excavation, Transportation, and Disposal of Petroleum-Contaminated Soils (ENSCI, Env. Inc., 1995)

Contaminated soils were removed based on the recommendations of the POL-CMS. The clean up goal was 100 mg/kg for TPH. Approximately 770 cubic yards of TPH-contaminated soil was excavated from SWMU 24. Soil was removed to the depth of the water table, but TPH concentrations in the confirmation samples remained above the cleanup goal of 100 mg/kg. Since excavation activities were terminated prior to meeting the cleanup goal for TPH, the USEPA requested confirmatory sampling of groundwater.

Phase II RCRA Facility Investigation (CH2M HILL, 1995)

Following the soil removal, additional groundwater investigation activities were conducted as part of the Phase II RFI. Nineteen groundwater samples were collected and analyzed for VOCs. Additionally, six shallow permanent monitoring wells were installed, sampled, and analyzed for VOCs, TPH, PAHs, total inorganics, and dissolved inorganics. The sample results indicated chlorinated VOCs in the deeper portion of the shallow aquifer and POL-related VOCs in the upper portion of the shallow aquifer. Maximum concentrations of trichlorothene (TCE) and total dichloroethene (DCE) were 81 µg/L and 700 µg/L, respectively. Ethylbenzene, xylenes, and naphthalene were detected at maximum concentrations of 19 J µg/L, 48 J µg/L, and 52 µg/L, respectively. Several inorganics were also detected in groundwater including arsenic, iron, and manganese at maximum total concentrations of 151.8 µg/L, 39,700 JF µg/L, and 436 JF µg/L, respectively. Additional groundwater sampling was recommended to determine the horizontal and vertical extent of the VOC plume.

Corrective Measures Study (CH2M HILL, 1996)

Groundwater was further investigated during the CMS on the basis of the recommendations of the Phase-II RFI. Groundwater samples were collected from five existing and four new monitoring wells and analyzed for VOCs. The CMS determined that groundwater was contaminated with chlorinated VOCs, specifically, vinyl chloride, cis-1,2-dichloroethene (cis-1,2-DCE), and TCE. The corrective action objectives for site groundwater were to prevent vertical and lateral migration of contaminated groundwater. Groundwater cleanup goals were developed on the basis of industrial land use for TCE (33 μg/L), cis-1,2-DCE (276 μg/L), and vinyl chloride (2.9 μg/L). For this study, residential use, MCLs, and beneficial reuse of groundwater were not considered in developing cleanup goals. Three alternatives were evaluated to address the groundwater contamination at SWMU 24: (1) No Action, (2) Plume Monitoring and Remediation of the Hot Spot, and (3) Plume Containment and Extraction at the Hot Spot. The recommended alternative was Plume Monitoring and Remediation of the Hot Spot (Alternative 2).

Phase III RCRA Facility Investigation (CH2M HILL, 1999)

Ten subsurface soil samples were collected during the Phase III RFI to confirm VOCs and PAHs in soil were at acceptable concentrations following the 1995 soil removal. The maximum detected concentrations were compared to the human health residential risk-based concentrations (RBCs). No industrial or residential RBCs were exceeded in any of the subsurface soil samples collected. Therefore, human health risks in soil were considered acceptable, and no additional action was recommended. A SERA was recommended to evaluate potential exposure pathways and risks to ecological receptors.

In-situ Aeration Pilot Test (CH2M HILL, 1996--1997)

In late 1996 and early 1997, an in-situ aeration pilot study was initiated at SWMU 24 to reduce the concentrations of VOCs in groundwater. This treatment method involved air stripping to remove VOCs from groundwater. Concentrations of VOCs were significantly reduced during the pilot study.

Direct-Push Technology Investigation (CH2M HILL, 1998)

A direct-push technology investigation was conducted to determine the boundaries of the cis-1,2-DCE groundwater plume and to assess the overall effectiveness of the in-situ aeration pilot study. Groundwater samples were also collected from the existing monitoring wells to support an HHRA. The groundwater sampling results indicated that VOC concentrations had been reduced to below MCLs in all but three monitoring wells and piezometers, suggesting the presence of a localized cis-1,2-DCE hot spot in the immediate vicinity of the former soil hot spot. The results of this groundwater investigation and subsurface soil samples collected following the soil removal were used to complete an HHRA.

Human Health Risk Assessment (CH2M HILL, 2001)

The HHRA characterized risks to potential future receptors from exposure to post-removal subsurface soil and groundwater. There were no constituents detected above the RBCs in subsurface soil. Human health risks were identified on the basis of exposure to cis-1,2-DCE,

arsenic, iron, and manganese in groundwater by potential future residents. The detailed results of the risk assessment are included in Section 2.7.

Screening Ecological Risk Assessment (CH2M HILL, 1999)

In 1999, SWMU 24 was included in a multi-site SERA to determine if potentially complete exposure pathways exist for ecological receptors. No complete exposure pathways were identified at SWMU 24. Therefore, no action to address ecological risk was recommended for SWMU 24.

Feasibility Study (CH2M HILL, August 2001)

An FS was completed to develop and evaluate remedial alternatives for potential unacceptable human health risks associated with groundwater. PRGs were selected for the chemicals posing potential human health risks. The MCLs were selected as the PRGs for cis-1,2-DCE (70 µg/L) and arsenic (10 µg/L). Risk-based PRGs were developed for iron (2,300 µg/L) and manganese (310 µg/L) because an MCL value does not exist for these analytes. The remedial alternatives evaluated were (1) No Action, (2) Institutional Controls and LTM, and (3) Use of ORC®, Institutional Controls, and LTM. Each remedial alternative was evaluated with respect to the nine evaluation criteria provided in the NCP. The alternatives were then compared with one another with respect to their rating under the NCP evaluation criteria. Based on the comparative analysis, Alternative 2, Institutional Controls and LTM, was selected as the Preferred Alternative.

Hot-Spot Remediation Baseline Sampling and Background Investigation (2003)

In order to evaluate the potential for inclusion of SWMU 24 in the proposed in-situ hot-spot treatability study that was being developed for other Oceana SWMUs (SWMUs 2C and 2E), additional samples were collected at SWMU 24 to further characterize the nature and extent of organic concentrations in groundwater. This sampling was conducted in conjunction with the facility-wide background investigation for select inorganics. During this investigation, only cis-1,2-DCE was detected (83 µg/L) above the MCL (70 µg/L) at one monitoring well location (OW24-PZ03) at SWMU 24.

Additional Groundwater Sampling (2003-2004)

Since the concentration of cis-1,2-DCE detected in the 2003 study was very close to the MCL concentration and there was a decreasing trend in concentrations of this constituent, three additional rounds of sampling were completed in 2003 and 2004 to further evaluate trends in contaminant concentrations and to determine whether treatment would be necessary at SWMU 24. For this evaluation, groundwater samples collected from OW24-PZ03 were analyzed for chlorinated volatiles. Concentrations of chlorinated volatiles did not exceed the corresponding MCL values in any of the three rounds of sampling. Cis-1,2-DCE was the only chlorinated VOC detected. The maximum concentration of this chemical was 14 µg/L during the final round of monitoring, less than the MCL of 70 µg/L. Therefore the alternative proposed in the 2001 FS (Institutional Controls with LTM) was deemed no longer necessary to address organics at SWMU 24. However, arsenic concentrations remained above the MCL of 10 µg/L in samples collected during the 2004 groundwater monitoring. The NAS Oceana partnering team, comprising remedial project managers

(RPMs) from the Navy, USEPA, and VDEQ agreed that further evaluation of arsenic in groundwater was warranted.

Arsenic Technical Memoranda (CH2M HILL, 2005)

A statistical evaluation of arsenic in groundwater was completed to support an action determination at SWMU 24. Following guidelines for making risk management decisions, which were developed by the Navy, USEPA, and VDEQ RPM managers/supervisors, the NAS Oceana partnering team determined no action is warranted to address arsenic in groundwater at SWMU 24 based on the following rationale: (1) there is no discernable arsenic plume; (2) statistical analysis indicates that concentrations of arsenic upgradient of SWMU 24 are higher than concentrations downgradient, indicating that the source of arsenic is not related to site activities; (3) the central tendency non-cancer and cancer risks associated with exposure to arsenic in groundwater are comparable to the risk posed by exposure to arsenic at the MCL concentration; and (4) the availability of potable water within the vicinity of SWMU 24 further reduces the potential that groundwater from the site would ever be used as potable water. Arsenic concentrations in groundwater are shown on **Figure 2-5**.

2.3 Community Participation

In accordance with Sections 113 and 117 of CERCLA, the Navy has maintained a public involvement program for several years to encourage community involvement in the CERCLA decision making process at NAS Oceana sites. Starting in 1989, a Technical Review Committee (TRC) met semiannually to discuss investigative activities at NAS Oceana. The TRC included mostly government personnel and a few private citizens. In November, 1994, the Navy converted the TRC into a Restoration Advisory Board (RAB).

The investigations conducted at SWMUs 1 and 24 have been presented and discussed at the RAB meetings. Documents and relevant information relied upon in the remedy section process is available for public review in the public information repository located at: http://public.lantops-ir.org/sites/public/oceana/AdminRecords.aspx

For access to the Administrative Record or additional information, contact:

Public Affairs Office
NAVFAC Atlantic
Lafayette River Annex
6508 Hampton Boulevard
Norfolk, VA 23508

The Navy provided a public comment period from October 15 through November 15, 2007, for the proposed remedy described in the Proposed Plan (PP) for SWMUs 1 and 24. A public meeting to present the PP was held at the Virginia Beach Central Library, on, October 31, 2007. Public notice of the meeting and availability of documents was placed in *The Virginian-Pilot* on October 14 and October 17, 2007. No public comments or concerns were received during the meeting or the public comment period.

2.4 Scope and Role of Response Action

Sixty SWMUs were recommended for study in the RCRA Consent Order issued by the USEPA. After reviewing the Interim RFI results, the Navy and USEPA determined that 41 of these SWMUs required no action or should be regulated under other federal or state programs. Nineteen SWMUs required further investigation. The Navy combined four of the identified SWMUs into two, due to their relative proximity and similar site operations. Therefore, seventeen SWMUs were identified as needing further investigation under CERCLA. With the exception of SWMUs 1, 2B, 2C, 2E, and 24, the remaining SWMUs were closed out in CERCLA with no action. A DD for SWMUs 2B, 2C, and 2E is scheduled for 2008.

2.5 Site Characteristics

NAS Oceana is located in the Tidewater region of Virginia. The station lies southeast of Norfolk, immediately west of the Atlantic Ocean, and just south of the Chesapeake Bay. More than 40 percent of NAS Oceana is occupied by commercial, residential, and station operations buildings, or is open space among the runways, hangars, and similar structures. The elevation of the station ranges from approximately 5 ft above mean sea level (amsl) in drainage areas to 25 ft amsl in open fields. Elevations in the developed area of the station range from 10 to 25 ft amsl. Topography of the station is generally flat.

SWMU 1

The immediate area around SWMU 1 is dominated by trees, shrubs, grass, and herbs. A small freshwater emergent wetland is located approximately 250 ft east of the SWMU. Surface drainage is directed toward north-south and east-west oriented drainage ditches. The north-south (main) drainage ditch has a permanent flow of surface water to the north. The ditch is approximately 12 to 15 ft wide with steep side slopes about 5 ft high. The ditch generally maintains a low-volume base flow because it is regularly excavated to a depth below the water table. No vegetation has been observed in the stormwater drainage ditch and the ditch receives periodic maintenance to maintain unimpeded stormwater conveyance. A second east-west trending tributary drainage ditch is located south of SWMU 1 and conveys stormwater drainage west into the main drainage ditch. This tributary ditch is perched approximately 2 ft above the base of the main drainage ditch and is dry except during heavy precipitation events. This ditch contains small shrubs and grass and oxidized, non-saturated soils. It does not provide significant habitat for aquatic life.

The surficial geology of SWMU 1 consists of a 4 to 5 ft thick layer of brown sandy silt underlain by an 11 to 13 ft thick layer of clean, fine-to-very-coarse gray sand. These materials are members of the Columbia Group sediments. The Yorktown Formation underlies the sandy Columbia Group sediments and consists of gray silt. Shallow groundwater is generally encountered between 4 and 8 ft bgs and flows westward, discharging into the main drainage ditch at the site.

SWMU 24

SWMU 24 was used as a construction support facility for the Naval Construction Battalion (SEABEEs) from 1973 until early 2008. The SEABEEs recently relocated, and the area is now used for various storage and support activities. The site consists of a fenced gravel area surrounded by a perimeter of brush, forest, and mowed lawn.

The surficial geology of SWMU 24 consists of a 4 to 5-ft thick layer of brown sandy silt underlain by an 11 to 30 ft thick layer of clean, fine to very coarse gray sand. These sediments comprise the Columbia aquifer at the site. The Yorktown confining unit has not been encountered at SWMU 24 during previous investigations. SWMU 24 shallow groundwater is encountered at approximately 5 to 9 ft bgs and generally flows to the south/southwest.

2.6 Current and Potential Future Land and Resource Uses

SWMU 1 is located in the northwest part of NAS Oceana, approximately 1,000 ft west of abandoned Runway 9. SWMU 1 is currently not being used by the facility. The location of the former pit is surrounded by trees, shrubs, grass, and herbs. There are no buildings or facilities located within the vicinity of SWMU 1. SWMU 24 is currently used for logistic and storage purposes. The SWMU consists of a gravel lot and industrial buildings. SWMU 24 is bounded to the southeast by the base golf course and the southwest by a large wooded area. No groundwater extraction wells are present within the boundaries of SWMUs 1 or 24 or in the immediate vicinity of the SWMUs.

There is currently no plan to modify the existing use of the land or groundwater at SWMUs 1 and 24. Future residential development of the SWMUs is unlikely; however, conservative residential scenarios were evaluated in the HHRA.

2.7 Summary of Site Risks

2.7.1 Human Health Risk Assessment Summary

A Baseline HHRA was completed for SWMUs 1 and 24 to evaluate potential risks from current and future human exposure to site media. The HHRAs for SWMUs 1 and 24 are an estimate of the likelihood of health problems occurring if no cleanup action is taken. Potential cancer risks and noncancer hazards were calculated on the basis of conservative reasonable maximum exposure (RME) concentrations that portray the highest level of human exposure that could be expected to occur, and more realistic central tendency (CT) exposure concentrations based on more reasonable exposure levels.

Potential unacceptable cancer risks are expressed as the probability that a person has greater than a 1 in 10,000 ($1x10^{-4}$) chance of developing cancer within the USEPA's acceptable risk range of 10^{-4} to 10^{-6}. The potential for noncancer hazards was evaluated by comparing an exposure level over a specified time period with a reference dose concentration that an individual may be exposed and not harmfully affected. The ratio of exposure to toxicity is called a hazard quotient (HQ). An HQ greater than 1 indicates that a receptor's dose of a single contaminant is greater than the reference dose and that exposures may present an

unacceptable risk. The hazard index (HI) is generated by adding the HQs for all chemicals of potential concern (COPCs) that affect the same target organ or that act through the same mechanism of action within a medium or across all media to which a given individual may reasonably be exposed. For noncancer, an HI value greater than 1 may indicate exposures that may present an unacceptable risk. A summary of the HHRA results for each SWMU is provided below.

SWMU 1

Potential risks based on risk screening were identified during the HHRA associated with soil (dermal contact and ingestion), groundwater (dermal contact, ingestion, and inhalation), and sediment (dermal contact). The potential human receptors evaluated were the current and future industrial worker, current and future adult trespasser/visitor, current and future adolescent trespasser/visitor, future construction worker, and future adult and child residents.

Surface water constituent concentrations did not exceed the human health risk-based screening values; therefore, risk was not further quantified. The noncancer hazards and cancer risks associated with exposure to drainage ditch sediments were below or within USEPA's acceptable levels.

On the basis of current land use scenarios, there were no unacceptable risks or hazards associated with exposure to soil or groundwater. Additionally there were no unacceptable risks or hazards associated with future land use by adult/adolescent trespasser/visitors, construction workers, and industrial workers.

The noncancer hazard associated with exposure to site soil by the future adult resident is 0.40, which is below USEPA's target threshold of 1. The noncancer hazard associated with exposure to site soil by future child residents is 1.8 primarily due to ingestion of surface and subsurface soil. However, there were no individual target organ effects (HQs) greater than 1 and the CT noncancer HI was below 1. Additionally, the cancer risk (CR = 2.5×10^{-5}) associated with the future lifetime (child through adult) residential use of the site was within USEPA's acceptable risk range (10^{-4} to 10^{-6}). Therefore, there were no unacceptable risks for potential future residents due to exposure to site soil.

The HHRA (CH2M HILL, 2001) established that potable use of site groundwater was within USEPA's acceptable cancer risk range (CR =2.5×10^{-5}); however, potable use would result in a noncancer hazard for adult (HI=10) and child (HI=1.3) residents due to ingestion, dermal contact, and inhalation of naphthalene. Although benzene and 1,1-DCA were detected in previous investigations, no unacceptable risks were identified for these constituents.

During the development of the FS, a PRG of 170 µg/L for naphthalene in groundwater was calculated on the basis of a hypothetical future residential exposure. Following the HHRA and FS, four rounds of groundwater samples were collected at SWMU 1 to evaluate the contaminant concentration trends. Naphthalene was not detected in groundwater above the PRG during this 1-year groundwater-monitoring period, indicating that the groundwater no longer poses unacceptable human health risks to future receptors. Although benzene did not present an unacceptable risk, this constituent was monitored as previously detected concentrations exceeded the MCL. Concentrations were below the MCL during the last three rounds of monitoring (**Figure 2-4**).

SWMU 24

A quantitative HHRA was not conducted for surface soil because contaminated soil at the site was excavated and confirmation samples did not exceed human health risk-based screening criteria. Potential human health risks were assessed for future land use by an industrial worker, construction worker, and resident. It was assumed that these receptors could be exposed to subsurface soil through incidental ingestion, dermal contact, and inhalation of fugitive emissions from soil. The noncancer hazard (HI = 0.0016) for the future child resident (most conservative scenario) associated with exposure to subsurface soil was below USEPA's target level (1.0). Additionally, the future lifetime cancer risk ($7.8x10^{-10}$) associated with exposure to subsurface soil is below USEPA's target risk range (10^{-4} to 10^{-6}).

During the HHRA (CH2M HILL, 2001), potential human health risks associated with ingestion and dermal contact with groundwater by future residents and dermal contact by future construction workers were calculated. The noncancer hazard (HI=0.53) and cancer risk ($1.1x10^{-6}$) associated with dermal contact with groundwater by future construction workers were below USEPA's target levels. RME noncancer hazards were identified on the basis of the use of groundwater as a potable residential water supply. The RME noncancer hazard for exposure to groundwater by child (HI=31) and adult (HI=14) residents were above the USEPA's target HI of 1. Additionally, the CT noncancer hazards were also above the target HI for child (HI=21) and adult (HI=12) residents. These hazards were primarily associated with ingestion of cis-1,2-DCE, arsenic, iron, and manganese. Potable use of groundwater would also pose an RME cancer risk ($2x10^{-3}$) and CT cancer risk ($6.8x10^{-4}$) above USEPA's acceptable risk range of $1x10^{-4}$ to $1x10^{-6}$ due to ingestion of arsenic. However, the potential risks associated with cis-1,2-DCE, arsenic, iron, and manganese in groundwater are considered acceptable on the basis of the following:

- cis-1,2-DCE - concentrations detected in groundwater-sampling events conducted after the HHRA was completed were below the MCL of 70 µg/L, indicating that the groundwater no longer poses unacceptable human health risks to future receptors from exposure to cis-1,2-DCE as documented in *2003 and 2004 Groundwater Sampling Results for SWMUs 1, 2B, and 24, NAS Oceana, Virginia Beach, Virginia* (CH2M HILL, 2004).

- Arsenic - Additional groundwater sampling and statistical analysis conducted after the HHRA was completed indicated that (1) there is no discernable arsenic plume; (2) statistical analysis indicates that concentrations of arsenic upgradient of SWMU 24 are higher than concentrations downgradient, indicating that the source of arsenic is not related to site actitivities; (3) the central tendency noncancer and cancer risks associated with exposure to arsenic in groundwater are comparable to the risks posed by exposure to arsenic at the MCL concentration; and (4) the availability of potable water within the vicinity of SWMU 24 further reduces the potential that groundwater from the site would ever be used as potable water. These conclusions are documented in *Considerations for Risk Management of Arsenic in Groundwater at NAS Oceana SWMU 24* (CH2M HILL, 2005a) and *Groundwater Arsenic Data Review and Statistical Analysis, SWMU 24, Naval Air Station Oceana, Virginia Beach, Virginia* (CH2M HILL 2005b).

- Iron - Exposure to iron in groundwater is not considered a health concern for the future resident because iron is an essential human nutrient. The estimated RME and CT intakes of iron via ingestion of groundwater (2.3 mg/kg-day and 1.5 mg/kg-day) are only

slightly above the recommended daily allowance range for children ages 6 months to 10 years (0.36 – 1.11 mg/kg-day) (EPA, January 1999). Additionally, the intake is below the maximum daily intake that is likely to pose risk for adverse effects (the Dietary Reference Intake Tolerable Upper Intake Level of 40 mg/day, equivalent to an intake of 2.7 mg/kg-day calculated by dividing 40 mg/day by the child body weight of 15 kg, USDA, 2006). Based on this rationale, no additional action to address iron is warranted.

- Manganese - Exposure to manganese in the groundwater is not expected to be a health concern for the future resident. Although the oral reference dose for manganese is not provisional, the derivation of toxicity factors for essential nutrients is complicated because manganese is an essential human nutrient responsible for activating several enzymes (EPA, 2006). The IRIS profile for manganese states,

  > *The reference dose is estimated to be an intake for the general population that is not associated with adverse health effects; this is not meant to imply that intakes above the reference dose are necessarily associated with toxicity. Some individuals may, in fact, consume a diet that contributes more than 10 mg Mn/day without any cause for concern (EPA, 2006).*

  The combined RME intake from ingestion (0.021 mg/kg-day) and dermal contact (0.000056 mg/kg-day) for a future child resident is much lower than the Dietary Reference Intake Tolerable Upper Intake Level of 2 mg/day for a child 1 to 3 years of age (USDA, 2006), which is equivalent to an intake of 0.13 mg/kg-day calculated by dividing 2 mg/day by the child body weight of 15 kg. Based on this rationale, no action to protect human health is warranted.

2.7.2 Ecological Risk Assessment Summary

A SERA and BERA (through Step 3a) were performed for SWMU 1 and a SERA was performed for SWMU 24 in accordance with USEPA guidance and Navy policy. The ecological risk assessments are an estimate of the likelihood of ecological problems occurring if no cleanup action is taken. A summary of the ecological risk assessment results are provided by SWMU below.

SWMU 1

An ecological risk assessment was conducted for SWMU 1, consisting of Steps 1 through 3a of the Navy ERA process. In Step 1 (problem formulation), the environmental setting, chemical fate and transport, ecotoxicity and potential receptors, and complete exposure pathways were considered in order to develop an ecological conceptual site model (CSM) and assessment and measurement endpoints. Potential habitats identified consisted of the terrestrial habitat, and the limited aquatic habitat in the regularly maintained (through excavation and removal of vegetation) stormwater conveyance on the west side of the site. The assessment of the environmental setting at the site did not identify the drainage ditch that runs east-west as a viable aquatic habitat because it is dry except during periods of heavy rain. Potentially complete exposure pathways were identified for both lower trophic level (e.g., earthworms) and upper trophic level (e.g., great blue heron) terrestrial and aquatic receptor populations based on chemicals in surface soil, surface water, and sediment at SWMU 1.

In Step 2, HQs were calculated to characterize the potential for chemicals to pose ecological risk using conservative exposure assumptions. HQs are used an an estimate of potential risk and are calculated as a ratio of the exposure level to an ecological effect level. In Step 2, the exposure level for lower trophic level receptors was the maximum detected chemical concentration in an exposure medium. For upper trophic level receptors, the exposure level was the dietary dose estimated through food web modeling, based on the maximum concentrations. For soil, sediment, and surface water (lower trophic receptors), the effect levels were Region III Biological Technical Assistance Group (BTAG) screening values. Upper trophic receptor effect levels were the No Observed Adverse Effect Levels (NOAELs) for reference toxicity values obtained from the scientific literature. Following food web modeling of bioaccumulative chemicals, potential risks were identified for upper trophic level receptors. Chemicals with HQs in excess of 1 were identified for each receptor population and selected as COPCs. Because COPCs were identified in Step 2, the ERA proceeded to Step 3A.

In Step 3A, the conservative exposure assumptions employed for Step 2 were refined and risk estimates (i.e., HQs) were recalculated using the same assessment/measurement endpoints. The primary refinement included using average, instead of maximum chemical concentrations and Lowest Observed Adverse Effect Levels (LOAELs) instead of NOAELs as the basis for exposure and estimating upper trophic-level doses. Following the refined risk calculations, the list of COPCs was revised to include only those chemicals with HQs still in exceedance of 1 based on the less conservative assumptions. The potential for those COPCs yielding refined HQs that were greater than 1 to pose unacceptable risk was further characterized using multiple lines-of-evidence such as upgradient concentrations and background concentrations as described below.

- Five inorganics and seven PAHs were identified as COPCs in surface soil. A statistical comparison of these COPCs to base-wide background surface soil data was performed to evaluate the potential significance of these exceedences. None of the inorganic COPCs exceed background soil concentrations. While, two of the individual PAHs exceed background, the total PAH concentration in site soil did not exceed the ecological screening value.
- In groundwater (potentially discharging to the north-south ditch), benzo(a)pyrene was the only chemical detected at a concentration above the ecological screening value. Benzo(a)pyrene was not detected in any of the surface water or sediment samples indicating that discharge of this chemical to the drainage ditch is not likely to impact ecological receptors.
- Two inorganics (aluminum and iron) were identified as COPCs in surface water. Concentrations of these inorganics detected within the site were below concentrations of these constituents detected in upgradient samples, suggesting they are not site-related.
- There were no COPCs identified for sediment at SWMU 1.
- Following food web modeling of bioaccumulative chemicals, none of the estimated exposure doses of COPCs for upper trophic level receptors exceeded the screening values based on the LOAELs.

Potential risks to ecological receptors from PAHs in surface soils and groundwater and inorganics in surface soil and surface water were determined to be negligible based on the lines of evidence above. Based on the food web modeling, no unacceptable risks were identified for upper trophic level receptors. Therefore, no action is recommended to protect ecological receptors at SWMU 1.

SWMU 24

No complete exposure pathways to ecological receptors were identified for SWMU 24 during the 2001-2002 SERA. Therefore, no risk was identified and no action is necessary to protect ecological receptors.

2.8 No Action Necessary

The Navy, in consultation with USEPA and VDEQ, agree that no action is required for SWMUs 1 and 24. Consequently, with the exception of No Action, no remedial action alternatives were considered and the development of remedial action objectives (RAOs) is not necessary. There are no principal threat wastes at the SWMUs and a No Action determination meets the statutory requirements of CERCLA Section 121 and the regulatory requirements of the NCP for protection of human health and the environment. No remedial response actions will be performed at SWMUs 1 and 24, and no restrictions on land use or exposure are necessary.

2.9 Documentation of Significant Changes

The PP for SWMUs 1 and 24 identified No Action as the preferred alternative. No members of the public attended the public meeting for the SWMUs 1 and 24 PP, and no comments were received during the public comment period. Therefore, no significant changes were made to the preferred remedial action alternative identified in the PP. No significant changes to the remedy have been made since the time it was presented as the Preferred Alternative in the PP.

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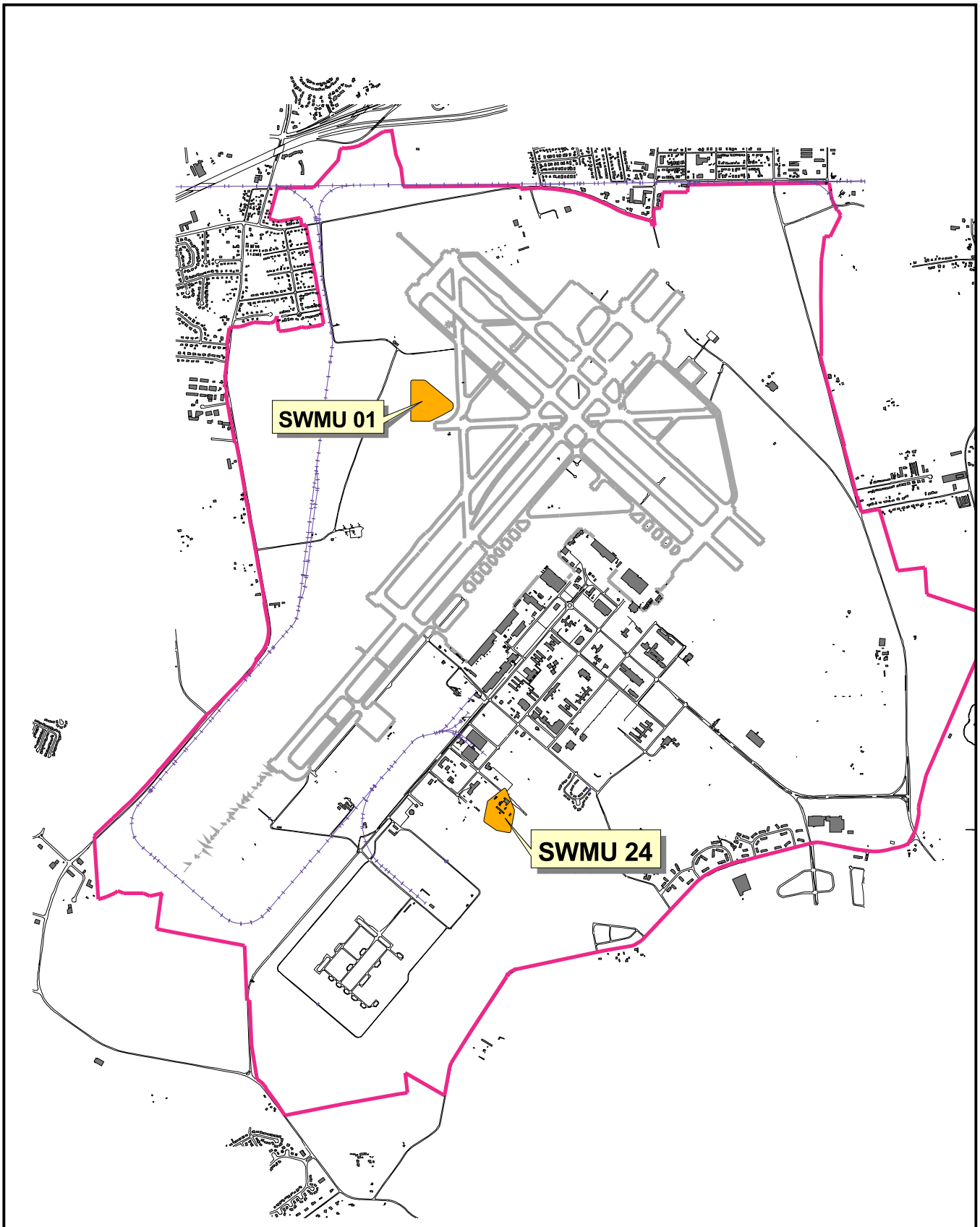

Figure 2-1
NAS Oceana Location and Vicinity
NAS Oceana, Virginia Beach, Virginia

CH2MHILL

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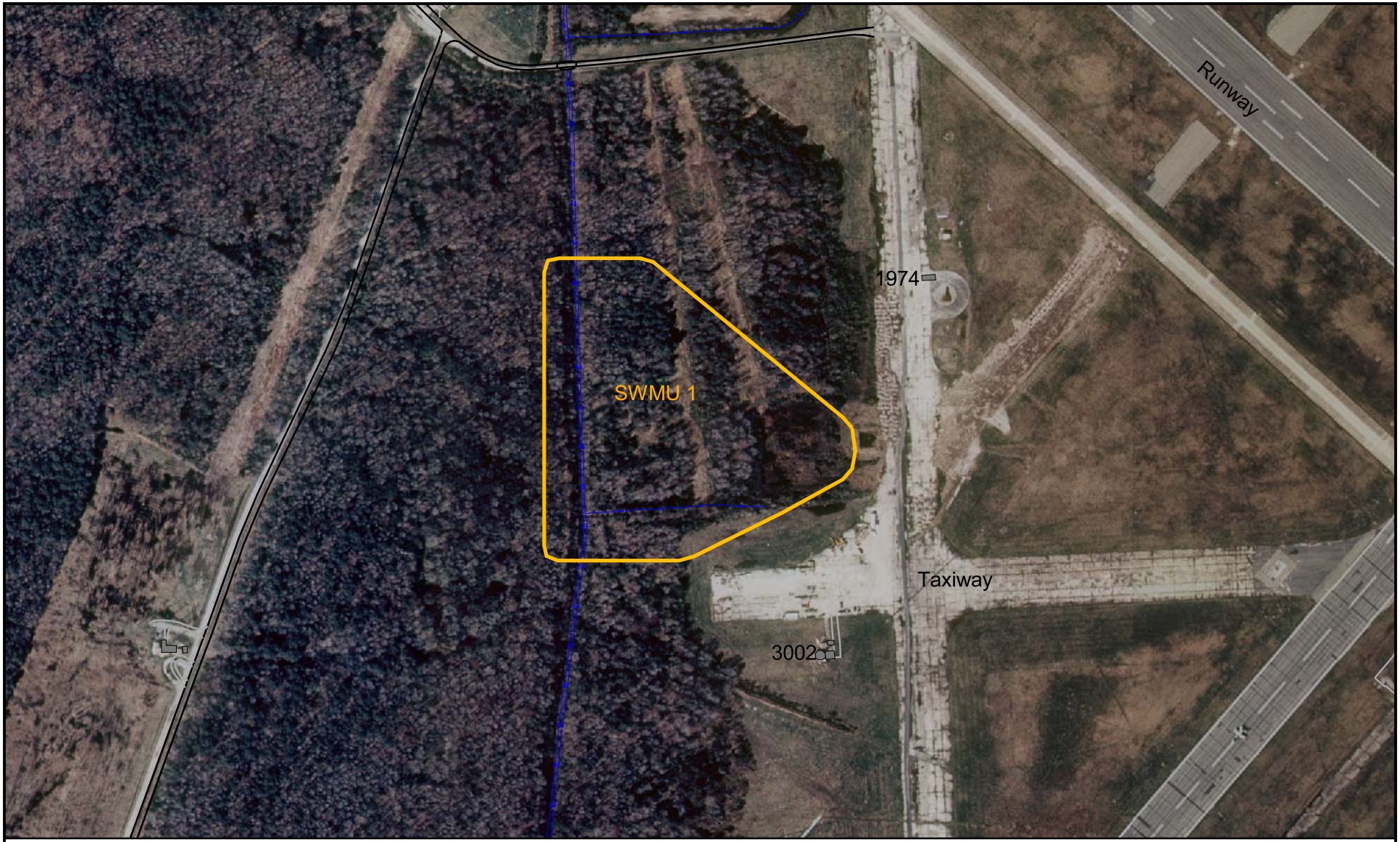

LEGEND

- OCEANA SWMUs
- Roads
- Stormwater Drains

N

0 200 400 Feet

Figure 2-2
SWMU 1 Location and Vicinity
NAS Oceana
Virginia Beach, Virginia

CH2MHILL

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LEGEND

- OCEANA SWMUs
- Roads
- Stormwater Drains

N

0 200 400 Feet

Figure 2-3
SWMU 24 Location and Vicinity
NAS Oceana
Virginia Beach, Virginia

CH2MHILL

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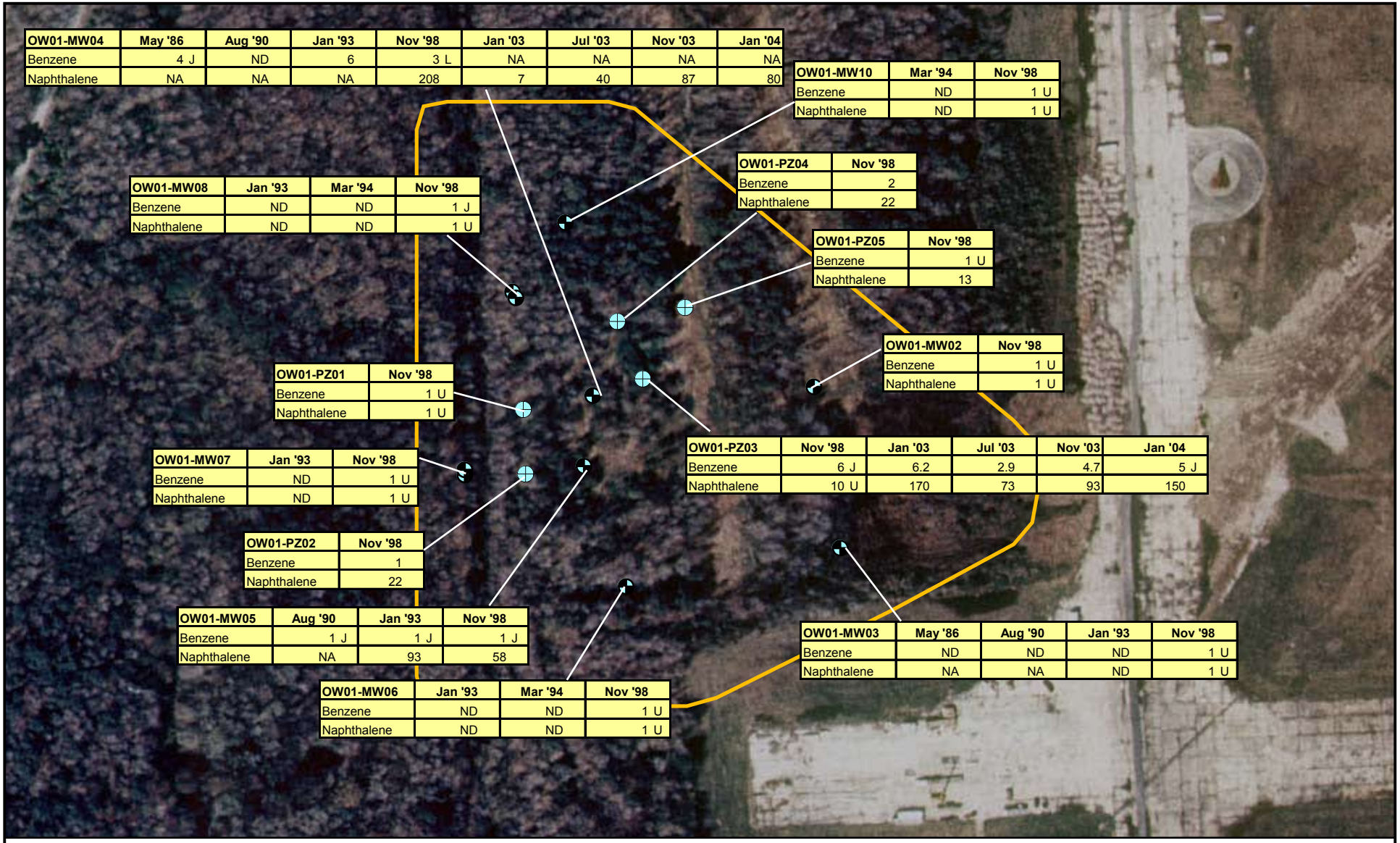

LEGEND

- Monitoring Well
- Piezometer
- SWMU 1 Boundary

N

0 100 200 Feet

Figure 2-4
SWMU 1 Historic Benzene
and Naphthalene Concentrations
NAS Oceana, Virginia, Virginia

CH2MHILL

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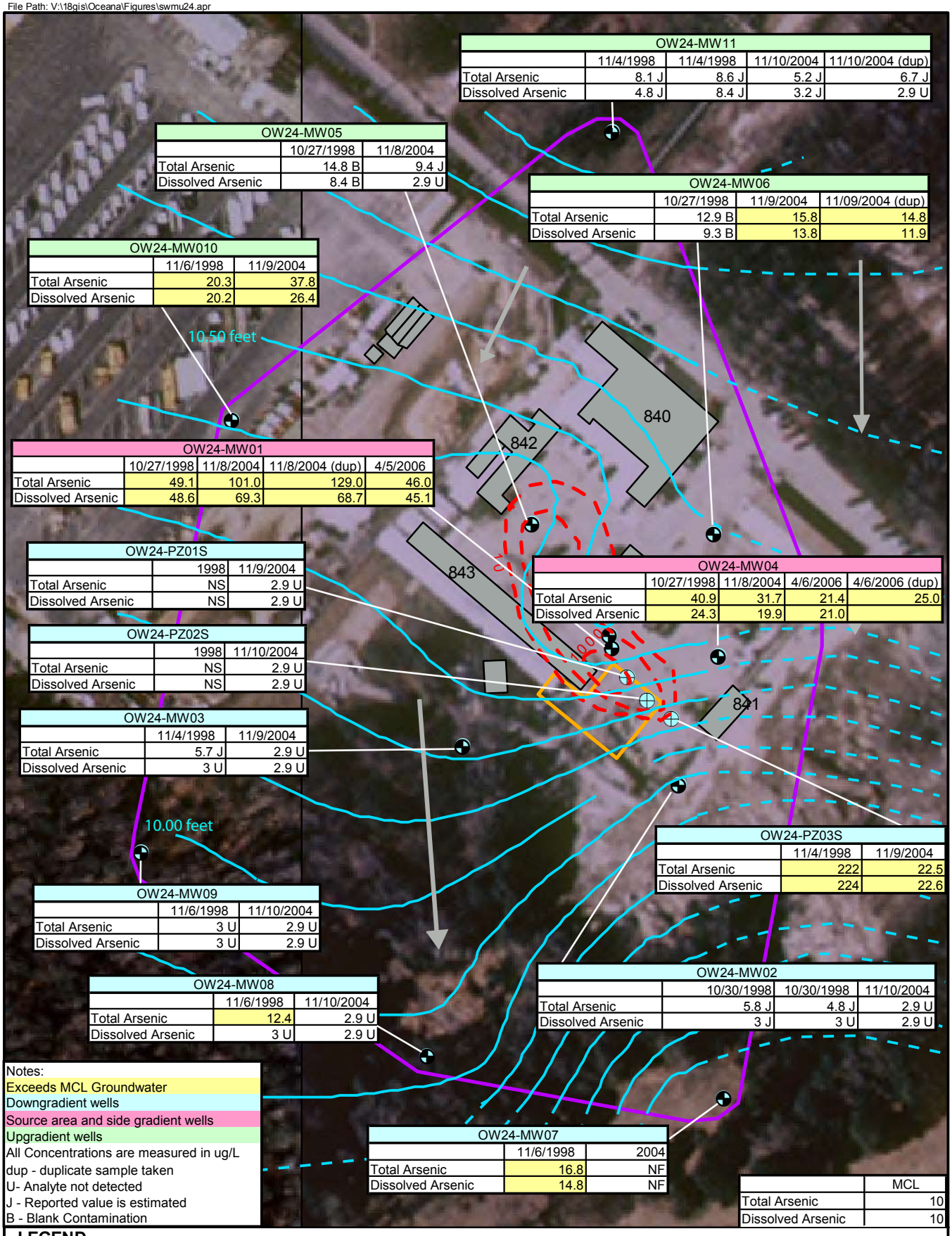

Figure 2-5
Arsenic Concentrations in Groundwater
SWMU 24, 1998, 2004, and 2006 Data
NAS Oceana
Virginia Beach, Virginia

CH2MHILL

SECTION 3

Responsiveness Summary

Public input is a key element in the decisionmaking process. The PP was made available on October 15, 2007. In accordance with Sections 113 and 117 of CERCLA, the Navy provided a public comment period, from October 15, 2007 through November 15, 2007 for the proposed remedial action described in the PP for SWMUs 1 and 24. The PP was available to the public in the Administrative Record and the Information Repository for NAS Oceana.

A public meeting was held on October 31, 2007, at the Virginia Beach Central Library to formally present the PP for SWMUs 1 and 24. Public notice of the meeting and availability of documents was placed in *The Virginian-Pilot* newspaper on October 14, 2007 and October 17, 2007. Navy representatives were available to present the PP and to answer any questions on the PP and on the documents in the Information Repository. No one from the public attended the public meeting, and no comments were received from the public during the public comment period.

SECTION 4

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Appendix A
Preliminary Remediation Goal Calculation Tables from the 2000 Feasibility Study

Table A-1
Preliminary Remediation Goals
Groundwater
Adult Residential Scenario
SWMU 1, NAS Oceana

Chemical	Chronic Oral RfD (RfDo) (mg/kg-day)	Chronic Dermal RfD (RfDd) (mg/kg-day)	Chronic Inhalation RfD (RfDi) (mg/kg-day)	Target Organ	DAevent (L/cm^2-day)	Shower Exposure (L/day)	Noncarcinogen Groundwater PRG HQ = 0.1 (mg/L)	HQ = 0.5 (mg/L)	HQ = 1 (mg/L)	Noncarcinogen PRG PRG (mg/kg)	Target HQ[1] (mg/kg)
SVOCs											
Naphthalene	2.00E-02	1.60E-02	9.00E-04	body weight	6.2E-05		4.1E-02	2.1E-01	4.1E-01	4.1E-01	1.00

Noncarcinogenic calculations:

$$\textbf{Groundwater RBC (mg/L)} = \frac{THQ \times BW \times AT_n}{EF \times ED \times (An + Bn + Cn)}$$

An = 1/RfDo x IR

Bn = 1/RfDd x SA x DAevent

Cn = 1/RfDi x Shower Exposure

EXPOSURE ASSUMPTIONS	
BW - Body weight (kilograms)	70
ATnc - Averaging time for noncarcinogens (days)	8,760
ATc - Averaging time for carcinogens (days)	25,550
EF - Exposure frequency (days/year)	350
ED - Exposure duration (year)	24
IR - Ingestion rate (L/day)	2
SA - Skin surface area (cm^2)	20,000

NA - No reference dose or slope factor available.

1 Applicable HQ calculated so that total HQ for a target organ does not exceed 1.

Table A-1a
Calculation of DAevent
Groundwater, Adult
SWMU 1, NAS Oceana

Chemical of Potential Concern	Permeability Constant (PC) (cm/hr)	Lag Time (t) (hr)	Duration of Event (ET) (hr)	t* (hr)	B (dimensionless)	DAevent (L/cm^2-day)	Eq
Naphthalene	6.9E-02	5.3E-01	2.0E-01	2.2E+00	2.0E-01	6.2E-05	2

Inorganics: DAevent (mg/cm2-event) =
PC x ET x CF2 (eq 1)

Organics: DAevent (mg/cm2-event) =

ET<t*: DAevent (mg/cm2-event) =
2 x PC x (sqrt((6 x t x ET)/3.1415))
x CF2 (eq 2)

Permeability constants from EPA 1992, Dermal Exposure Assessment: Principals and Applications.
ORD, EPA/600/8-91/001B. Default value of 0.001 cm/hour used for inorganics without published values.
N/A - not applicable.

Table A-2
Preliminary Remediation Goals
Groundwater
Child Residential Scenario
SWMU 1, NAS Oceana

Chemical	Chronic Oral RfD (RfDo) (mg/kg-day)	Chronic Dermal RfD (RfDd) (mg/kg-day)	Chronic Inhalation RfD (RfDi) (mg/kg-day)	Target Organ	DAevent (L/cm^2-day)	Noncarcinogen Groundwater PRG HQ = 0.1 (mg/L)	HQ = 0.5 (mg/L)	HQ = 1 (mg/L)	Noncarcinogen PRG PRG (mg/L)	Target HQ[1]
SVOCs										
Naphthalene	2.00E-02	1.60E-02	9.00E-04	body weight	8.0E-05	1.7E-02	8.7E-02	1.7E-01	1.7E-01	1.00

Noncarcinogenic calculations:

$$\textbf{Groundwater RBC (mg/L)} = \frac{THQ \times BW \times AT_n}{EF \times ED \times (An + Bn)}$$

An = 1/RfDo x IR

Bn = 1/RfDd x SA x DAevent

EXPOSURE ASSUMPTIONS	
BW - Body weight (kilograms)	15
ATnc - Averaging time for noncarcinogens (days)	2,190
ATc - Averaging time for carcinogens (days)	25,550
EF - Exposure frequency (days/year)	350
ED - Exposure duration (year)	6
IR - Ingestion rate (L/day)	1
SA - Skin surface area (cm^2)	7,930

NA - No reference dose or slope factor available.

1 Applicable HQ calculated so that total HQ for a target organ does not exceed 1.

Table A-2a
Calculation of DAevent
Groundwater, Child
SWMU 1, NAS Oceana

Chemical of Potential Concern	Permeability Constant (PC) (cm/hr)	Lag Time (t) (hr)	Duration of Event (ET) (hr)	t* (hr)	B (dimensionless)	DAevent (L/cm^2-day)	Eq
Naphthalene	6.9E-02	5.3E-01	3.3E-01	2.2E+00	2.0E-01	8.0E-05	2

Inorganics: DAevent (mg/cm2-event) =
PC x ET x CF2 (eq 1)

Organics: DAevent (mg/cm2-event) =

ET<t*: DAevent (mg/cm2-event) =
2 x PC x (sqrt((6 x t x ET)/3.1415))
x CF2 (eq 2)

Permeability constants from EPA 1992, Dermal Exposure Assessment: Principals and Applications.
ORD, EPA/600/8-91/001B. Default value of 0.001 cm/hour used for inorganics without published values.
N/A - not applicable.

Table A-3
Preliminary Remediation Goals
Groundwater
Lifetime Residential Scenario
SWMU 1, NAS Oceana

Chemical	Oral Slope Factor (CSFo) (kg-day/mg)	Dermal Slope Factor (CSFd) (kg-day/mg)	Inhalation Slope Factor (CSFi) (kg-day/mg)	DAevent-a (L/cm^2-day)	DAevent-c (L/cm^2-day)	Shower Exposure (L/day)	Carcinogen PRG Risk = 1E-06 (mg/L)	Carcinogen PRG Risk = 1E-05 (mg/L)	Carcinogen PRG Risk = 1E-04 (mg/L)
SVOCs									
Naphthalene	NA	NA	NA	6.2E-05	8.0E-05				

Carcinogen calculations:

$$\textbf{Groundwater RBC (mg/L)} = \frac{TR \times AT_c}{EF \times (Ac + Bc + Cc)}$$

Ac = CSFo x IRadj

Bc = CSFd x [(SAa x DAevent-a x EDa)/BWa + (SAc x DAevent-c X EDc)/BWc]

Cc = CSFi x Shower Exposure x EDa x 1/BWa

EXPOSURE ASSUMPTIONS	Lifetime	Adult (a)	Child (c)
BW - Body weight (kilograms)		70	15
ATnc - Averaging time for noncarcinogens (days)		8,760	2,190
ATc - Averaging time for carcinogens (days)		25,550	25,550
EF - Exposure frequency (days/year)		350	350
ED - Exposure duration (year)		24	6
IR - Ingestion rate (L/day)		2	1
IRdj - Ingestion rate (L-year/kg-day)	1.09		
SA - Skin surface area (cm^2)		20,000	7,930
ET - Exposure Time (hours/day)		0.20	0.33

NA - No reference dose or slope factor available.

Table A-3a
Calculation of DAevent
Groundwater, Child/Adult
SWMU 1, NAS Oceana

Chemical of Potential Concern	Permeability Constant (PC) (cm/hr)	Lag Time (t) (hr)	Duration of Event (ETa) (hr)	Duration of Event (ETc) (hr)	t* (hr)	B (dimensionless)	Daevent Adult (L/cm^2-day)	Daevent Child (L/cm^2-day)	Eq
Naphthalene	6.9E-02	5.3E-01	2.0E-01	3.3E-01	2.2E+00	2.0E-01	6.2E-05	8.0E-05	2

Inorganics: DAevent (mg/cm2-event) =
PC x ET x CF2 (eq 1)

Organics: DAevent (mg/cm2-event) =

ET<t*: DAevent (mg/cm2-event) =
2 x PC x (sqrt((6 x t x ET)/3.1415))
x CF2 (eq 2)

Permeability constants from EPA 1992, Dermal Exposure Assessment: Principals and Applications.
ORD, EPA/600/8-91/001B. Default value of 0.001 cm/hour used for inorganics without published values.
N/A - not applicable.

Table A-4
Recommended Preliminary Remediation Goals
Groundwater
Residential Scenario
SWMU 1 NAS Oceana

Chemical	Residential Scenario Recommended PRG (mg/L)	Basis
Naphthalene	1.7E-01	Child, HQ = 1

Child scenario selected for noncarcinogenic PRGs for residential scenario since child scenario is more conservative (lower PRGs).
Applicabe HQ chosen to keep total HI for each target organ below 1.